Theory Beyond the Standard Model (model building)

Ann Nelson, August 4, 2013
Theory Community Issues Panel

Why build (new) models?
"ideas are cheap. we need models"

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- baryogenesis, dark matter, hierarchy, strong CP, m_ν, flavor, unification
- connect theory to phenomenology
- explicit, motivated, consistent, inspiring, predictive
  - discover new mechanisms
  - new phenomena
  - inspire great experiments
  - inspire new experimental analyses

inspiration

- …..LHC
- GUTs inspire proton decay search
  - proton decay searches find SN1987A neutrinos and discover atmospheric neutrino oscillations
- Large extra dimensions inspire torsion balance short distance tests of Newton's law
  - discover that laws of gravity do not change on submillimeter scale
- axions inspire microwave cavity expts

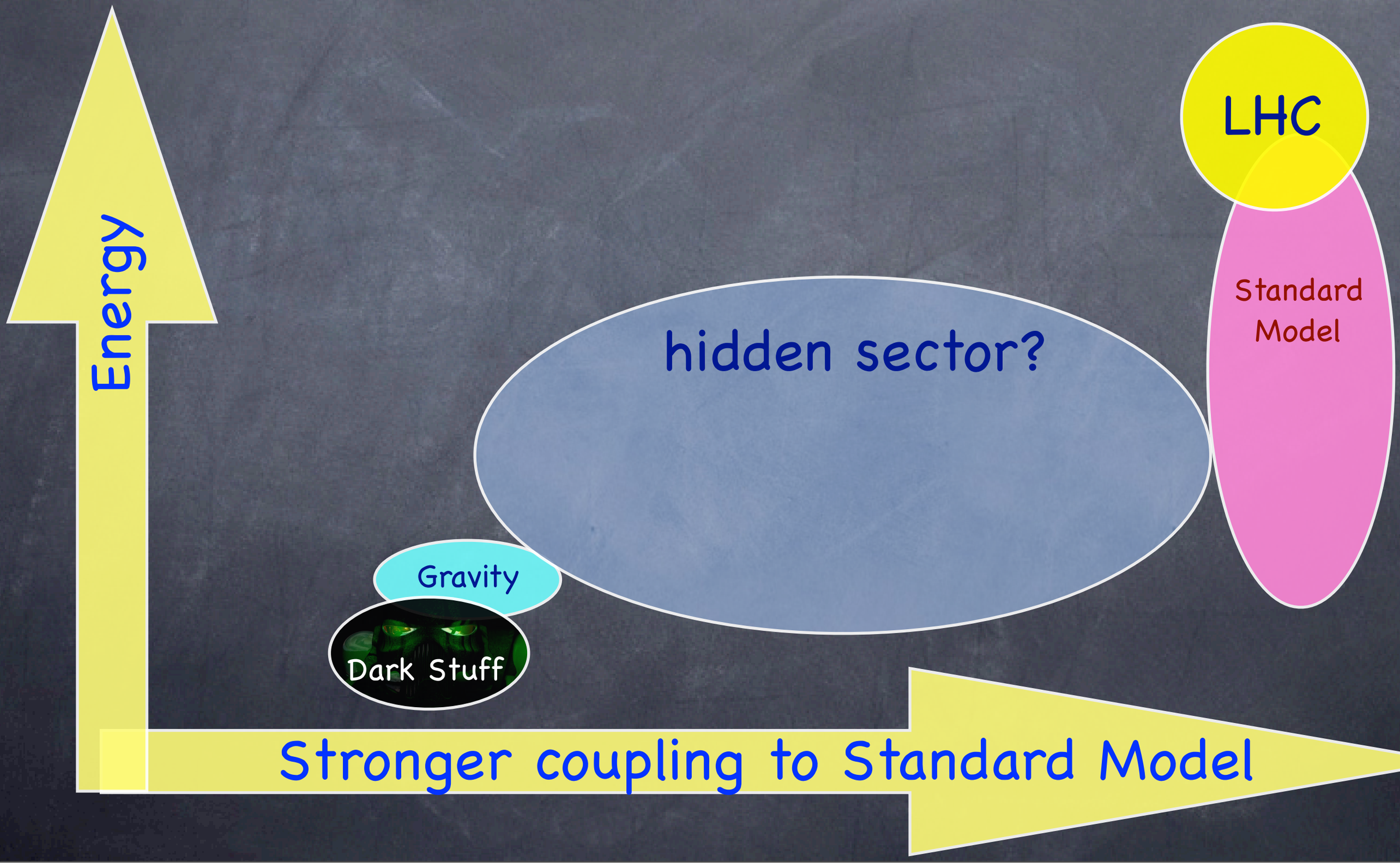
Track Record

- Theorists have been immensely successful at discovering good/correct models
  - Standard Model
  - Neutrino seesaw
- "We have a very limited palette" *-Sidney Coleman*
- **Terrible** track record at guessing parameters
  - top mass, Vcb, neutrino mixing, neutrino mass

LHC era

- "All your models are wrong" "we just need models to cover the signature space"
- range of models cover many triggers and analyses
- Large number of exotic models hugely expands breadth and interest of LHC
- "hidden valley" →long lived particle triggers
- History: expect surprises in the parameters
- may need the right model to correlate different categories of events to get a discovery
- some motivated reasons susy could be "stealthy"

Landscape of known and unknown unknowns



Intensity frontier/neutrino physics

- dark energy scale ~ neutrino mass
  ~ M_w^2/M_{Pl}~ one motivated range for $m_{3/2}$
  ~ short distance gravity test scale

- just as strong reasons to think about new, weakly coupled low scale physics as new TeV physics

  - naturalness
  - dark sector
  - experimental hints
  - guaranteed BSM: m_ν is new physics

New phenomena in neutrino sector

- LBNE has a great "bread and butter physics" program
  - measuring CPV, mass hierarchy (analogous to LHC measurement of Higgs properties)
- Needs a "new physics" complement
  - neutrinos are a possible portal to any hidden sector containing light fermion X
    - ℓ H X operator is renormalizable
    - X mixes with neutrinos, is 'sterile neutrino'
    - X can have other interactions, be part of dark matter and/or dark energy 'sector'

exotic ν physics

- possible connection with dark energy (MaVaNs)
- 'sterile neutrinos' with parameters "forbidden" by cosmology and astrophysics
- nonunitary in neutrino mixing matrix
- nonstandard CPV
- anomalous dependence on L/E
- anomalous matter effects